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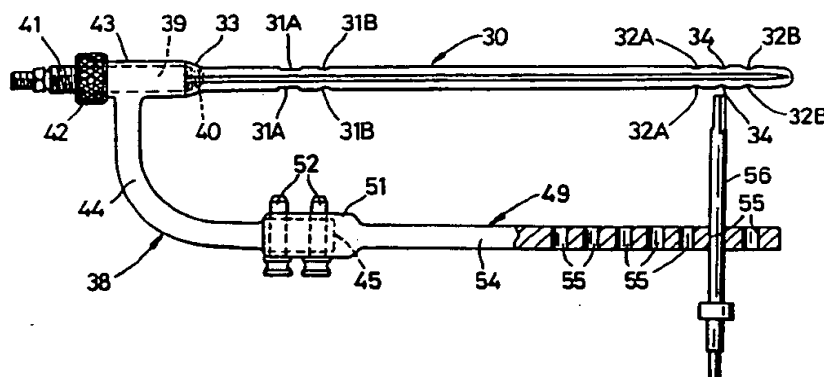
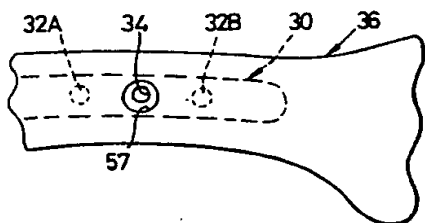
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** INTERLOCKING INTRAMEDULLARY NAILS**(57) Abstract**

To avoid using X-rays to target the distal bone screw holes (32A, 32B) of an interlocking intramedullary nail (30), the nail is provided with an additional transverse hole (34) for location of a short drilling jig after an "oversize" hole (57) has been drilled in the bone (36) "in register" with the location hole (34) by a drill (56) in a guide hole (55) in a long jig (49) accurately positioned from a standard proximal drill hole guide jig (38) "pre-located" to the nail (30). By "in register" is meant that the perimeter of the location hole (34) will lie within the perimeter of the "oversize" hole (57) in the bone (36), and the location hole (34) is of lesser diameter than the distal bone screw holes (32A, 32B) so that the "oversize" hole (57) in the bone (36) will not be damagingly large. Combination sets comprising a nail, bone screws, jigs and location means are also claimed.

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## INTERLOCKING INTRAMEDULLARY NAILS

This invention relates to interlocking intramedullary nails which usually have pairs of transverse holes in both a proximal region and at least one distal region to receive bone screws which effect the interlocking with bone portions, and to procedures for their securement.

A jig attached to the proximal end of the nail in "pre-located" fashion is used to locate guide holes for drilling holes in the bone aligned with the proximal screw holes. One model of nail (Huckstep) can be used with similar guide holes in a long jig for drilling holes in alignment with the distal screw holes, but this requires both the nail and the jig to be very rigid to ensure exact alignment of the distal guide holes with the distal screw holes.

Flexible nails (such as AO, Richards, Grosse and Kempf) are less likely to damage the bone on insertion, but this flexibility precludes the use of a long jig because distortion of the nail, flexurally and/or torsionally, is likely to cause misalignment of the distal guide holes and screw holes.

This problem has been tackled by means of a fluoroscopic targeting device using an image intensifier. This involves lining up a drill guide with the distal screw holes by means of an X-ray beam, the "shadows" of the holes in the guide and the holes in the nail being superimposed on the intensifier screen. With the drill guide thus correctly located, holes are then drilled in the bone to allow screws to be inserted.

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Although this method works it is popularly considered a fiddling task and can be quite time consuming. Furthermore, the surgeon's hands, the patient and operating theatre staff are often subjected to a considerable quantity of radiation.

The object of the invention is to provide means for the securement of interlocking intramedullary nails avoiding the aforementioned difficulties and dangers.

According to one aspect of the present invention, there is provided an intramedullary nail having proximal and distal bone screw holes, characterised in that there is also an additional transverse hole in its distal end region for use in location of a jig for drilling holes in a bone in alignment with the distal bone screw holes.

According to another aspect of the present invention, there is provided a combination set for the securement of flexible interlocking intramedullary nails, the set consisting of a long jig, a short jig, at least one nail, and bone screws; the nail having in its distal end region an additional transverse hole for use in location of the short jig; the long jig having means for use in attachment to the proximal end of the nail including guide holes for drilling holes in a bone in alignment with the proximal bone screw holes in the nail, and at least one "oversize" guide hole at its distal end for drilling an "oversize" hole in a bone "in register" with the short jig location hole in the nail; and the short jig having guide holes for drilling holes in a bone for the distal bone screws, and also location means for

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engagement at the location hole in the nail for effecting alignment of the guide holes with the distal screw holes in the nail.

By an "oversize" hole and "in register" with the short jig location hole is meant that the diameter of the "oversize" hole drilled in the bone is so much greater than the diameter of the location hole as to ensure that, regardless of flexing of the nail to any normal extent, the perimeter of the location hole will lie within the perimeter of the inner end of the "oversize" hole in the bone. It will be appreciated, therefore, that the diameter of a circular location hole is preferably appreciably less than the diameter of the distal bone screw holes, in order that the "oversize" hole in a bone will not be damagingly large.

The means for attachment of the long jig to the proximal end of the nail may be a socket on that end of the long jig to fit on to a standard "pre-located" proximal drill hole jig.

The location means on the short jig for engagement at the location hole in the nail preferably consists of a tubular stem the bore of which can serve as a guide for a screw (which may be self-tapping) or bolt or other means for securing the short jig to the nail while the distal bone screw holes are being drilled. With the usual formation of flexible nail being by transverse rolling of a strip of stainless steel or other biocompatible metal into a tube, the location hole preferably has a portion in opposite sides of the tube, at least one hole portion being circular, and possibly

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screwthreaded, for receiving the screw or bolt of the location means. The actual location of the tubular stem at the location hole may be by means of a "saddle" on the stem mating with the surface of the nail around a circular hole, or the tubular stem could be provided with diametrically opposed lugs for engaging in corresponding notches extending diametrically from the other portion of the location hole (preferably aligned with the longitudinal axis of the nail), or the end of the tubular stem could have a rectangular, square or other polygonal cross-section spigot for engaging a corresponding rectangular slot or a square or other polygonal shape forming that other portion of the location hole. It will be evident that the location hole may be conveniently disposed midway between a pair of distal bone screw holes.

The location hole would be located by direct vision through the "oversize" hole drilled in the bone with the aid of the "oversize" guide hole in the distal end of the long jig, and allows of accurate positioning of the short jig for drilling of holes for the distal bone screws without tedious and/or damaging use of radiation.

The long jig may be provided with a series of "oversize" guide holes for selectively matching the positions of location holes in a series of nails of different lengths.

Alternatively, the long jig and the short jig may be combined by providing a first rigid bar member having at one end a socket to fit a standard "pre-located" proximal drill hole jig and having towards its other end a series of equispaced length-adjusting holes, and by providing the "oversize"

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guide hole and distal guide holes at one end of a second rigid bar member having towards its other end a series of length-adjusting holes with the same spacing as the equi-spaced holes in the first rigid bar member, together with at least two bolting means for engaging any pair of length-adjusting holes in one rigid bar member with any corresponding pair of length-adjusting holes in the other rigid bar member. Thus, when the length of the long jig (i.e. the spacing of the "oversize" guide hole from the proximal guide holes) is set, the position of the "oversize" guide in relation to the location hole in the nail, is also set.

The bolting means preferably have a locking mode for securing the rigid bar members rigidly together while drilling through the "oversize" guide hole and an articulating mode for allowing slight articulation of the rigid bar members for effecting alignment of the location means through the "oversize" guide hole with the location hole in the nail. These modes may be provided by tightening up the bolting means (for the locking mode) or slackening them off (for the articulating mode). The locking mode is preferably adopted again when the location means has been engaged with the location hole in the nail. Each bolting means conveniently consists of a setscrew passing through one of a series of plain holes in one of the rigid bar members (preferably the second) and screwing into one of a series of screwthreaded holes in the other (e.g. first) rigid bar member.

The socket on the long jig or on the first rigid bar member is preferably provided with holes to register with the



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guide holes in a "pre-located" proximal drill hole jig, and pins are provided for locking the socket to the proximal drill hole jig by fitting closely in the pairs of registering holes.

The or each "oversize" guide hole may have a length equal to the thickness of the long jig or the second rigid bar member. Likewise, each distal guide hole may have a length equal to the thickness of the short jig or the second rigid bar member. Alternatively, the or each "oversize" guide hole may comprise a length of tube welded in a hole through the long jig or the second rigid bar member; and likewise, each distal guide hole may comprise a length of tube welded in a hole through the short jig or the second rigid bar member.

Embodiments of nails in accordance with the first aspect of the invention will now be described, by way of example only, with reference to Figures 1 to 7 of the accompanying drawings, and embodiments of combination sets in accordance with the second aspect of the invention and their manner of use will be described, by way of example only, with reference to Figures 8 to 21, the drawings being as follows:-

Figure 1 is a small scale side elevation of an interlocking intramedullary nail in accordance with the first aspect of the invention;

Figure 2 is an enlargement of the right-hand end or distal end of the nail of Figure 1;

Figure 3 is an even larger section on the line III-III of Figure 2;

Figure 4 corresponds to Figure 3 but shows a minor modification;

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Figure 5 corresponds to Figure 2, but illustrates another embodiment of nail in accordance with the invention;

Figure 6 is an enlarged section on the line VI-VI of Figure 5;

Figure 7 corresponds to part of Figure 2 or Figure 5, but illustrates a further embodiment of nail in accordance with the invention;

Figure 8 is a longitudinal section of a fractured bone with a nail in accordance with the invention shown interlocked with the bone by bone screws and viewed as from above in Figure 1;

Figure 9 is a similar view of the nail of Figure 8, with a standard "pre-located" proximal drill hole jig;

Figure 10 is a side elevation of a long jig forming part of a first combination set in accordance with the invention;

Figure 11 corresponds to Figure 9 but shows the long jig of Figure 10 fitted on the proximal drill hole jig of Figure 9 for use in drilling an "oversize" hole in a bone (See Figure 8) "in register" with a location hole in the nail;

Figure 12 is an enlarged fragmentary elevation of a bone around the distal region of a nail inserted therein and illustrating the "oversize" hole "in register" with the location hole;

Figure 13 is an elevation of a short jig forming another part of the first combination set, complete with location means;

Figure 14 is an elevation of the short jig from above

in Figure 13;

Figure 15 is an elevation of the short jig from the left-hand end of Figure 14;

Figure 16 corresponds to Figure 14, but shows the short jig secured by its location means to a nail in accordance with the invention, together with a bone drill shown in position for drilling a bone (not shown) in line with one of two distal bone screw holes in the nail;

Figure 17 corresponds to part of Figure 14 but shows a modification of the location means for use with the nail of Figures 5 and 6;

Figure 18 also corresponds to part of Figure 14 but shows a modification of the location means for use with the nail of Figure 7;

Figure 19 is a side elevation of a first rigid bar member forming part of a second combination set in accordance with the invention;

Figure 20 is a side elevation of a second rigid bar member forming another part of the second combination set;

Figure 21 corresponds to Figure 9 but shows the rigid bar members of Figures 19 and 20 locked together and fitted to the proximal drill hole jig of Figure 9 for use in drilling an "oversize" hole in a bone (see Figure 8) "in register" with a location hole in a nail (see Figure 12).

Figure 22 corresponds to Figure 21 but shows the bolting means between the bar members slackened off to allow slight articulation of the bar members for effecting alignment of location means with the location hole in the nail; and

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Figure 23 corresponds to Figure 22 but shows the second rigid bar member secured by its location means to the nail, and the bolting means between the bar members tightened again while a bone drill is used for drilling a bone (not shown) in line with first one distal bone screw hole and then the other.

The interlocking intramedullary nails 30 shown in the drawings are of the flexible type formed by transverse rolling of a strip of stainless steel or other biocompatible metal, into a tube, with a pair of proximal transverse bone screw holes 31A, 31B having a portion in opposite sides of the tube and one (31A) being elongated, and with a pair of distal transverse bone screw holes 32A, 32B likewise having a portion in opposite sides of the tube. The proximal end 33 of the tubular nail is flared and is internally screwthreaded for securing to a proximal drill hole jig (see Figure 9).

In accordance with the first aspect of the invention, there is also provided an additional transverse hole 34 in the distal end region for use in location of a jig (as will be described presently) for drilling holes in a bone in alignment with the distal bone screw holes 32A, 32B. The location hole 34 has a portion in opposite sides of the tube (see particularly Figures 3, 4 and 6), at least one hole portion being circular for receiving a screw or bolt of location means (also to be described presently) for the jig. In Figure 3 both hole portions are circular and plane for use with a self-tapping screw of the location means, while in Figure 4 one whole portion 34X is screwthreaded for use with a bolt of the

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location means. In Figures 5 and 6 the other hole portion 34Y is basically circular but has diametrically opposed notches 35, aligned with the longitudinal axis of the nail, for engagement by corresponding lugs on the location means, while in Figure 7 the other hole portion 34Z has a hexagonal shape for engagement by a hexagonal spigot on the location means. In all the embodiments of nail the location hole 34 is conveniently disposed midway between the pair of distal bone screw holes 32A, 32B.

In Figure 8 a nail 30 is shown in place in a fractured bone 36 and interlocked therewith by bone screws 37 through the holes 31A, 31B, 32A, 32B. The surgical procedure involved will now be described, firstly with reference to Figures 9 to 16, and then with reference to Figures 19 to 23.

As mentioned previously, the proximal end 33 of the nail is flared and internally screwthreaded for securing to a proximal drill hole jig 38 of standard form and which is "pre-located" by means of a stem 39 having a tapering screwthread 40 at one end to match the screwthread in the flared end 33 of the nail, the stem also having a screwthread 41 carrying a nut 42 for locking against the flared end of the nail a tubular portion 43 of the jig 38, and from which tubular portion extends a rigid curved arm 44 to a head 45 having a pair of guide holes 46A, 46B aligned (by virtue of the "pre-location" of the jig) with the proximal bone screw holes 31A, 31B, respectively, in the nail 30. A drill guide 47 is shown in the guide hole 46B, with a drill 48 passing through the drill guide and the hole 31B in the nail 30.

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After the holes have been drilled in the bone 36 in alignment with the proximal screw holes 31A, 31B, the head 45 of the jig 38 is used to mount another jig forming part of a combination set in accordance with the invention which includes a nail 30 with a location hole 34 (as previously described with reference to Figures 1 to 3, 4, 5 and 6 or 7), and bone screws 37.

A first combination set in accordance with the invention includes a long jig 49 (Figures 10 and 11) and a short jig 50 (Figures 13 to 16). The long jig 49 has a socket 51 to fit on the head 45 of the standard "pre-located" proximal drill hole jig 38 and is secured thereon by a pair of pins 52 through holes 53 in the socket and the holes 46A, 46B in the head 45 (see Figure 11). From the socket 51 of the long jig 49 extends a rigid bar 54 having a curvature matching the curvature of the nail 30 (c.f. Figures 1 and 10) and provided with a series of "oversize" guide holes 55 for selectively matching the positions of location holes 34 in a series of nails of different lengths, not shown but similar in all other respects to the nail 30 already described.

In Figure 11 a drill 56 is shown fitted in the guide hole 55 in the long jig 49 matching the position of the location hole 34 in the nail 30 and is used to drill in the bone 36 an "oversize" hole 57 (see Figures 8 and 12) "in register" with the location hole 34 in the nail; that is, the diameter of the "oversize" hole 57 is so much greater than the diameter of the location hole 34 as to ensure that, regardless of flexing of the nail to any normal extent, the perimeter of

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the location hole will lie within the perimeter of the inner end of the "oversize" hole in the bone, as is illustrated by Figure 12.

In Figures 13 to 16, the short jig 50, which forms another part of the first combination set in accordance with the invention, is seen as having guide holes 58A, 58B for use in drilling holes in the bone in alignment with the holes 32A, 32B in the nail 30 for the distal bone screws, and also location means 59 for engagement at the location hole 34 in the nail 30 through the "oversize" hole 57 in the bone. The location means 59 consists of a tubular stem 60, the bore of which serves as a guide for a self-tapping screw 61 for engaging the hole 34, the actual location of the tubular stem at the location hole being by means of a "saddle" 62 on the stem (see particularly Figure 15) mating with the surface of the nail around the hole 34, as can be seen in Figure 16, in which a drill guide 63 and drill 64 are shown fitted in the guide hole 58B. The short jig 50 is also provided with a handle 65 to facilitate holding it in place while the screw 61 is being screwed into the location hole 34 in the nail.

The modified short jigs shown in Figures 17 and 18 are generally similar to that of Figures 13 to 16 except that in Figure 17 the actual location of the tubular stem 60X at the location hole is by means of a pair of diametrically opposed lugs 66 for engaging in the corresponding notches 35 extending diametrically from the hole portion 34 in Figures 5 and 6, while in Figure 18 the actual location is by means of a hexagonal spigot 67 on the tubular stem 60Y for engaging in the

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hexagonal hole portion 34Z in Figure 7.

A second combination set in accordance with the invention has the long jig and the short jig combined by providing a first rigid bar member 68 (Figure 19) having at one end a socket 51 with holes 53 to fit a standard "pre-located" proximal drill hole jig 38 (in the same manner as the long jig 49 in Figure 11), and having towards its other end a series of equi-spaced length-adjusting holes 69, and by providing the "oversize" guide hole 55 and distal guide holes 58A, 58B at one end of a second rigid bar member 70 (Figure 20), having towards its other end a series of length-adjusting holes 71 with the same spacing as the equi-spaced holes 69 in the first rigid bar member 68, together with two bolting means 72 for engaging any pair of length-adjusting holes in one rigid bar member with any corresponding pair of length-adjusting holes in the other rigid bar member, as shown by Figure 21, in which a drill 56 is shown fitted in the guide hole 55 brought into general alignment with the location hole in the nail 30 by selective pairing of the length-adjusting holes 69, 71 and the bolting means 72.

In Figure 21 the bolting means have been tightened up (into a locking mode) to secure the rigid bar members 68, 70 rigidly together, with an index mark 73 on the upper surface of the second rigid bar member 70 in register with one of a series of registration marks 74 on the upper surface of the first rigid bar member 68 aligned with the axes of the respective holes 69. After the "oversize" hole 57 has been drilled in the bone, the drill 56 is removed from the hole 55



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and replaced by location means 59 (see Figure 22), consisting of a tubular stem 60 (having an integral stop collar 75), the bore of which serves as a guide for a screw 61 for engaging the location hole 34 in the nail 30 when the bolting means 72 have been slackened off (to assume an articulating mode) for allowing slight articulation of the rigid bar members 68, 70 for effecting alignment of the location means 59 with the location hole 34, the locking mode being adopted again (by tightening the bolting means 72 again) when the screw 61 has been engaged with the hole 34, see Figure 23, which drawing also shows a drill guide 63 and drill 64 in the guide hole 58A.

The "oversize" guide hole 55 and the distal guide holes 58A, 58B each comprise a length of tube 76 welded in a hole through the second rigid bar member 70, and each bolting means consists of a setscrew passing through one of the series of holes 71 (which are plain holes) in the second rigid bar member 70 and screwing into one of the series of holes 69 (which are screwthreaded) in the first rigid bar member 68.

## CLAIMS

1. An intramedullary nail (30) having proximal and distal bone screw holes (31A, 31B and 32A, 32B), characterised in that there is also an additional transverse hole (34) in its distal end region for use in location of a jig (50 or 72) for drilling holes in a bone (36) in alignment with the distal bone screw holes (32A, 32B).

2. An intramedullary nail as in Claim 1, characterised in that the additional transverse hole (34) is a circular hole having a diameter appreciably less than the diameter of the distal bone screw holes (32A, 32B).

3. An intramedullary nail as in Claim 1 or Claim 2, characterised in that the nail (30) is formed by transverse rolling of a strip of biocompatible metal into a tube, the location hole (34) having a portion in each side of the tube, at least one hole portion being circular.

4. An intramedullary nail as in Claim 3, characterised in that the circular portion (34X) of the location hole (34) is screwthreaded.

5. An intramedullary nail as in Claim 3 or Claim 4, characterised in that the other portion (34Y) of the location hole (34) has diametrically opposed notches (35).

6. An intramedullary nail as in Claim 5, characterised in that the notches (35) are aligned with the longitudinal axis of the nail (30).

7. An intramedullary nail as in Claim 3 or Claim 4, characterised in that the other portion (34Y) of the location hole (34) has a polygonal shape.

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8. An intramedullary nail as in any one of Claims 1 to 7, characterised in that the location hole (34) is disposed midway between a pair of distal bone screw holes (32A, 32B).

9. A combination set for the securement of flexible interlocking intramedullary nails, the set consisting of a long jig (49), a short jig (50), at least one nail (30), and bone screws (37); the nail (30) having in its distal end region an additional transverse hole (34) for use in location of the short jig (50); the long jig (49) having means (51, 53) for use in attachment to the proximal end (33) of the nail (30) including guide holes (46A, 46B) for drilling holes in a bone (36) in alignment with the proximal bone screw holes (31A, 31B) in the nail, and at least one "oversize" guide hole (55) at its distal end for drilling an "oversize" hole (57) in a bone "in register" with the short jig location hole (34) in the nail; and the short jig (50) having guide holes (58A, 58B) for drilling holes in a bone for the distal bone screws, (37) and also location means (59) for engagement at the location hole (34) in the nail (30) for effecting alignment of the guide holes (58A, 58B) with the distal screw holes (32A, 32B) in the nail.

10. A combination set as in Claim 9, characterised in that the means for attachment of the long jig (49) to the proximal end (33) of the nail (30) is a socket (51) on that end of the long jig to fit on to a standard "pre-located" proximal drill hole jig (38).

11. A combination set as in Claim 9 or Claim 10, characterised in that the location means (59) on the short jig

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(50) for engagement at the location hole (34) in the nail (30) consists of a tubular stem (60) the bore of which can serve as a guide for a screw (61) or bolt or other means for securing the short jig (50) to the nail (30) while the distal bone screw holes are being drilled.

12. A combination set as in Claim 11, characterised in that the screw (61) of the location means (59) is self-tapping.

13. A combination set as in Claim 11 or Claim 12, characterised in that the actual location of the tubular stem (60) at the location hole (34) is by means of a "saddle" (62) on the stem mating with the surface of the nail (30) around a circular hole.

14. A combination set as in Claim 11 or Claim 12, characterised in that the tubular stem (60) is provided with diametrically opposed lugs (66) for engaging in corresponding notches (35) extending diametrically from a portion (34Y) of the location hole (34).

15. A combination set as in Claim 14, characterised in that the lugs (66) are aligned with the longitudinal axis of the nail.

16. A combination set as in Claim 11 or Claim 12, characterised in that the tubular stem (60) has a rectangular, square or other polygonal cross-section spigot (67) for engaging a corresponding rectangular slot or a square or other polygonal shape (34Z) forming a portion of the location hole (34).

17. A combination set as in any one of Claims 9 to

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16, characterised in that the long jig (49) is provided with a series of "oversize" guide holes (55) for selectively matching the positions of location holes (34) in a series of nails (30) of different lengths.

18. A combination set as in any one of Claims 9 to 16, characterised in that the long jig and the short jig are combined by providing a first rigid bar member (68) having at one end a socket (51) to fit a standard "pre-located" proximal drill hole jig (38) and having towards its other end a series of equi-spaced length-adjusting holes (69), and by providing the "oversize" guide hole (55) and distal guide holes (58A, 58B) at one end of a second rigid bar member (70), having towards its other end a series of length-adjusting holes (71) with the same spacing as the equi-spaced holes (69) in the first rigid bar member (68), together with at least two bolting means (72) for engaging any pair of length-adjusting holes in one rigid bar member with any corresponding pair of length-adjusting holes in the other rigid bar member.

19. A combination set as in Claim 18, characterised in that the bolting means (72) have a locking mode for securing the rigid bar members (68, 70) rigidly together while drilling through the "oversize" guide hole (55) and an articulating mode for allowing slight articulation of the rigid bar members (68, 70) for effecting alignment of the location means (59) through the "oversize" guide hole (55) with the location hole (34) in the nail (30).

20. A combination set as in Claim 19, characterised in that each bolting means (72) consists of a setscrew passing

through one of a series of plain holes (71) in one of the rigid bar members (70) and screwing into one of a series of screwthreaded holes (69) in the other rigid bar member (68).

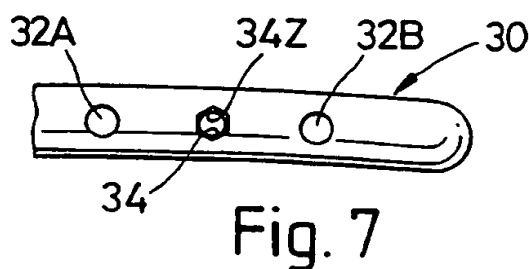
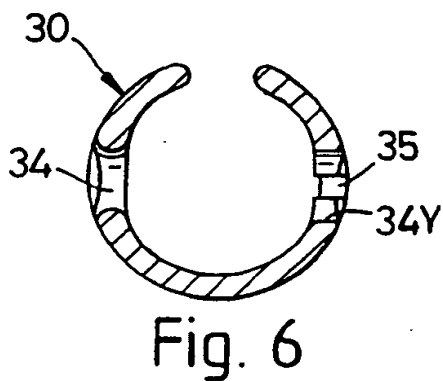
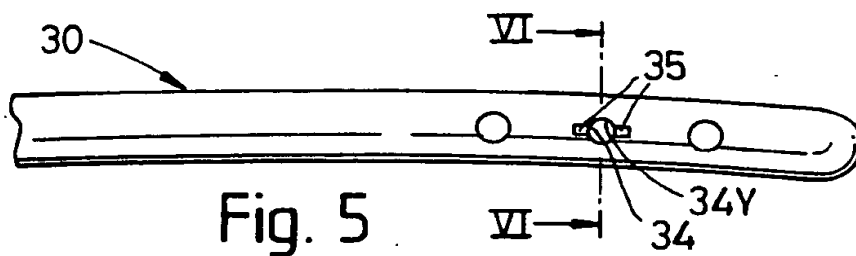
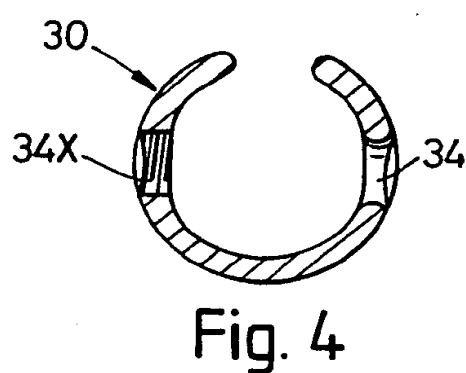
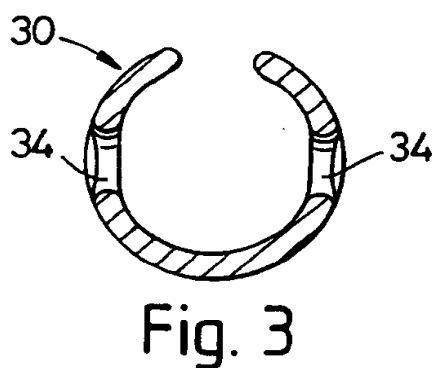
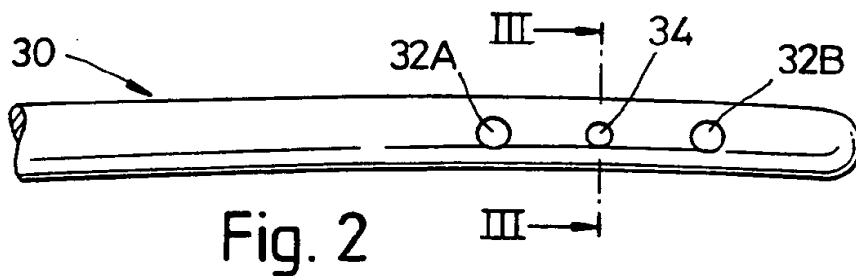
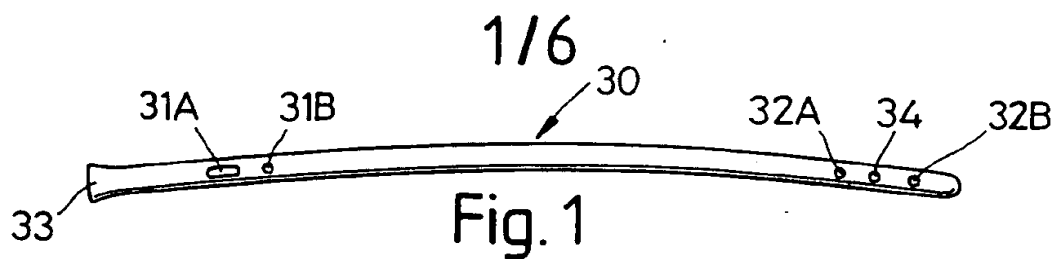
21. A combination set as in Claim 10 or Claim 18, characterised in that the socket (51) on the long jig (49) or on the first rigid bar member (68) is provided with holes (53) to register with the guide holes (46A, 46B) in a "pre-located" proximal drill hole jig, (38), and pins (52) are provided for locking the socket to the proximal drill hole jig (38) by fitting closely in the pairs of registering holes.

22. A combination set as in any one of Claims 9 to 21, characterised in that the or each "oversize" guide hole (55) has a length equal to the thickness of the long jig (49) or the second rigid bar member (70).

23. A combination set as in Claim 22, characterised in that each distal guide hole (58A, 58B) has a length equal to the thickness of the short jig (50) or the second rigid bar member (70).

24. A combination set as in any one of Claims 9 to 21, characterised in that the or each "oversize" guide hole (55) comprises a length of tube (76) welded in a hole through the thickness of the long jig (49) or the second rigid bar member (70).

25. A combination set as in Claim 24, characterised in that each distal guide hole (58A, 58B) comprises a length of tube (76) welded in a hole through the thickness of the short jig (50) or the second rigid bar member (70).



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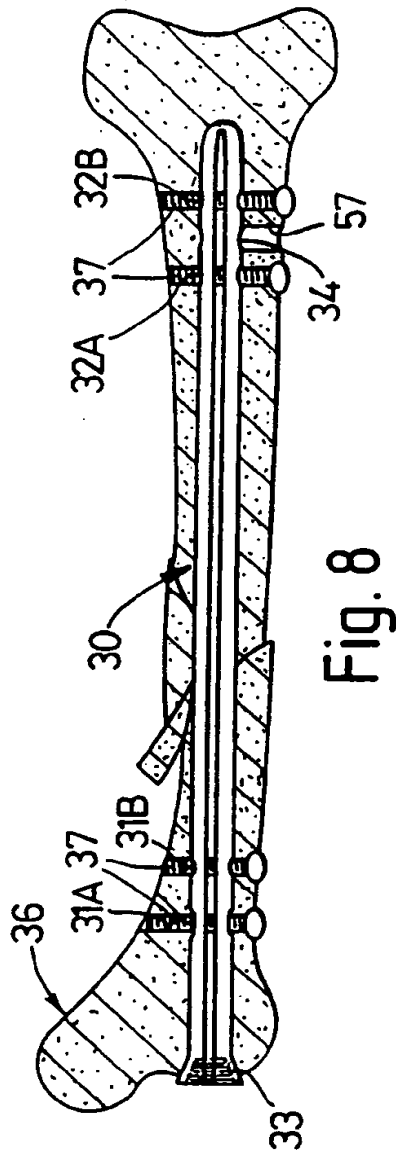


Fig. 8

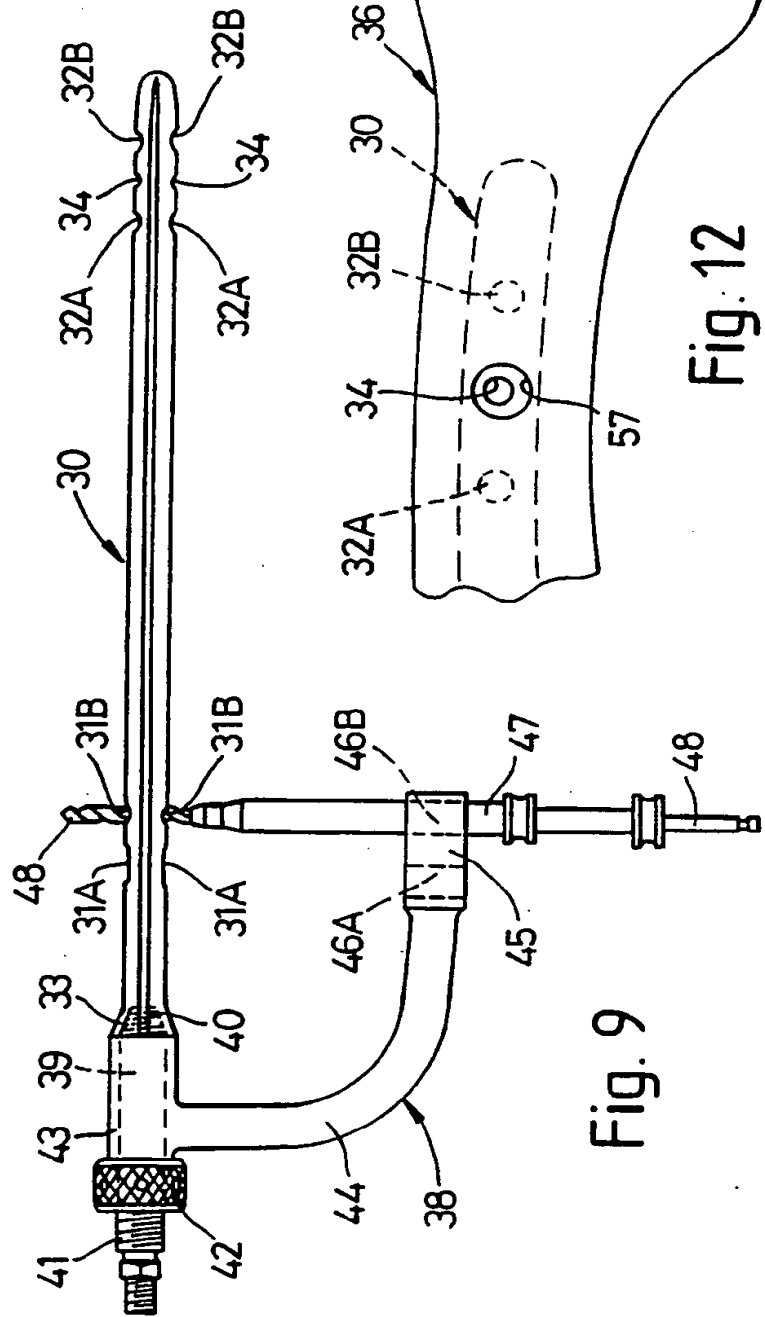


Fig. 9

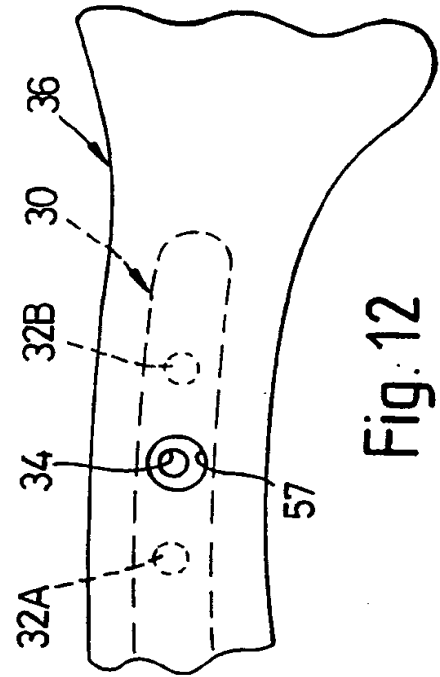


Fig. 12



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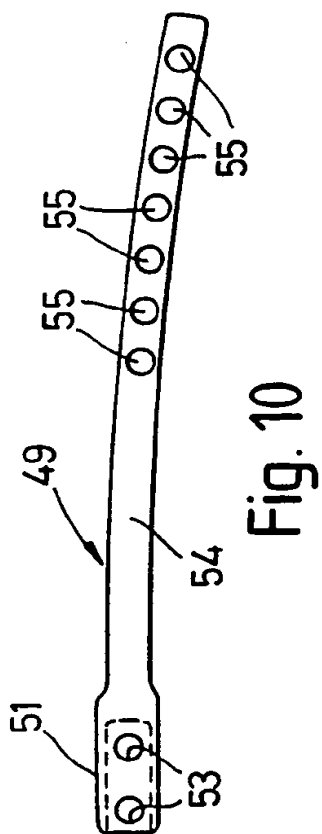


Fig. 10

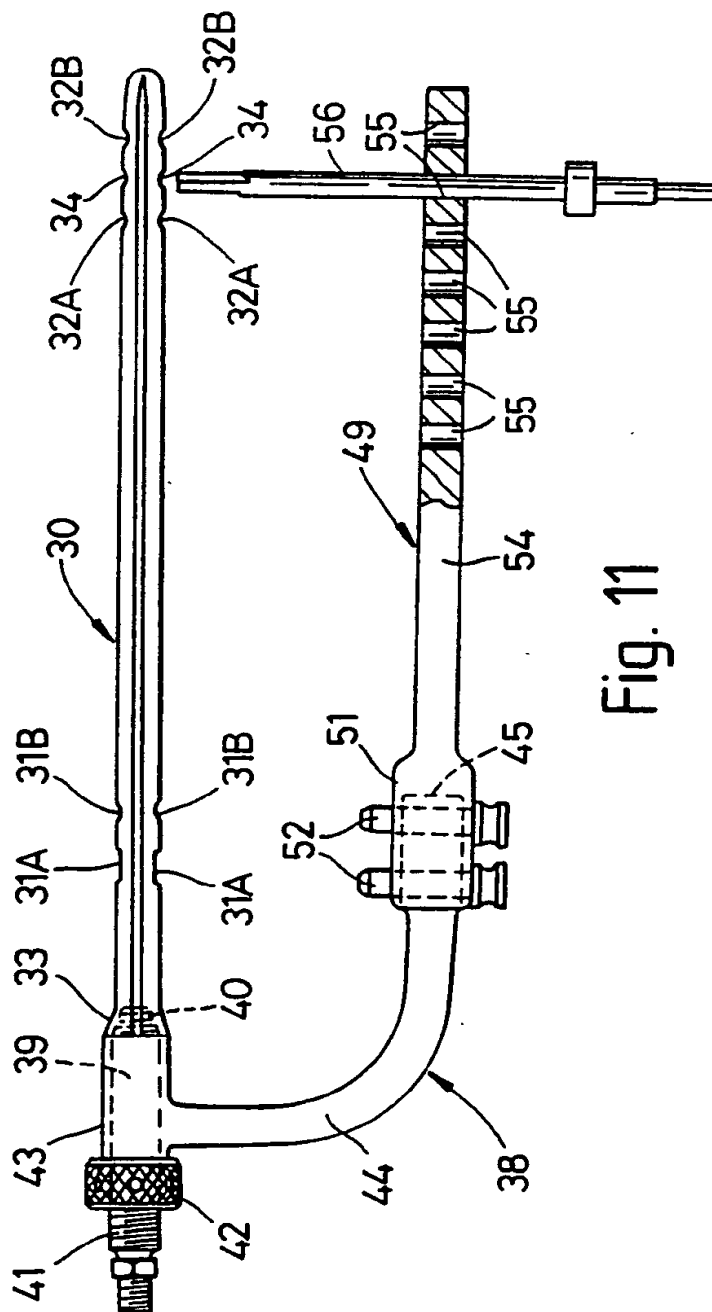


Fig. 11

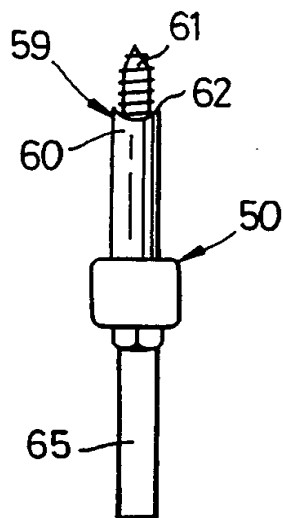


Fig. 15

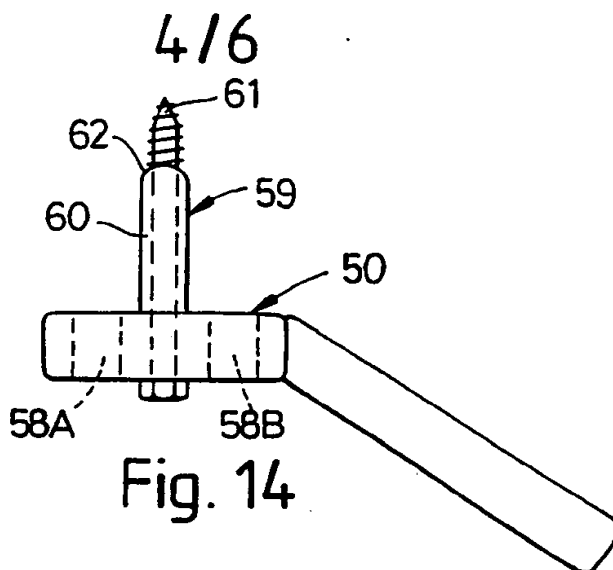


Fig. 14

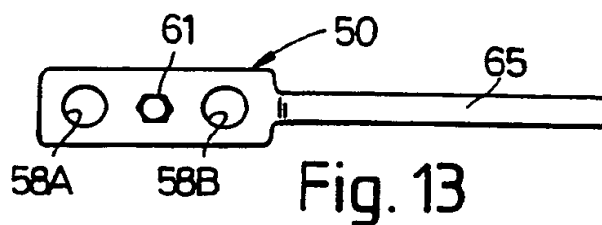


Fig. 13

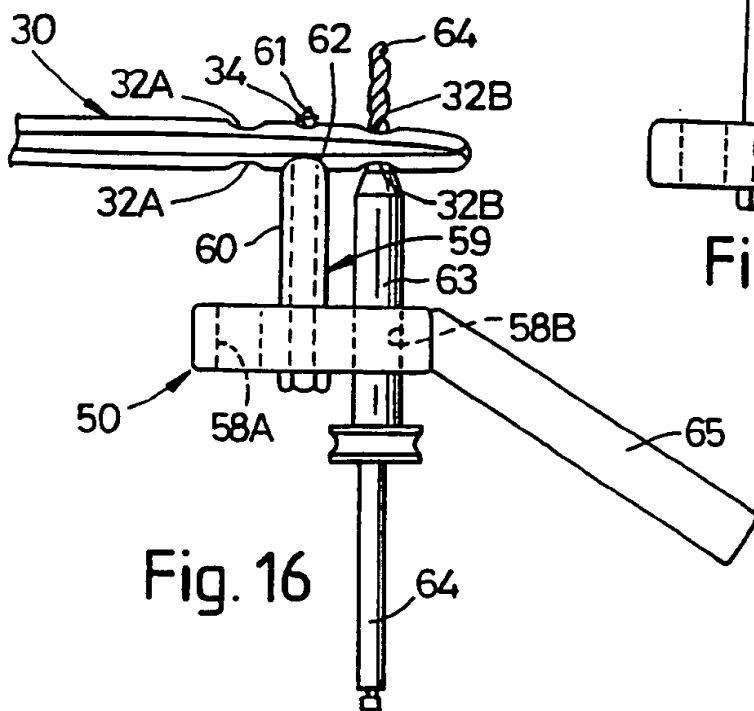


Fig. 16

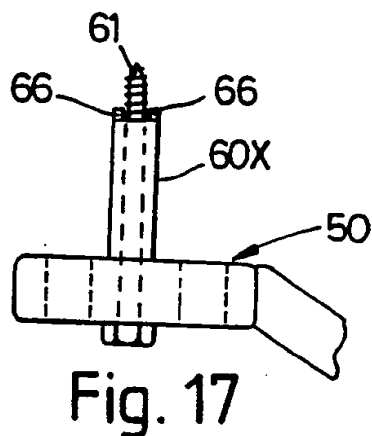


Fig. 17

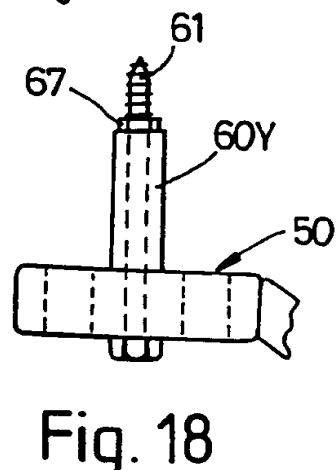
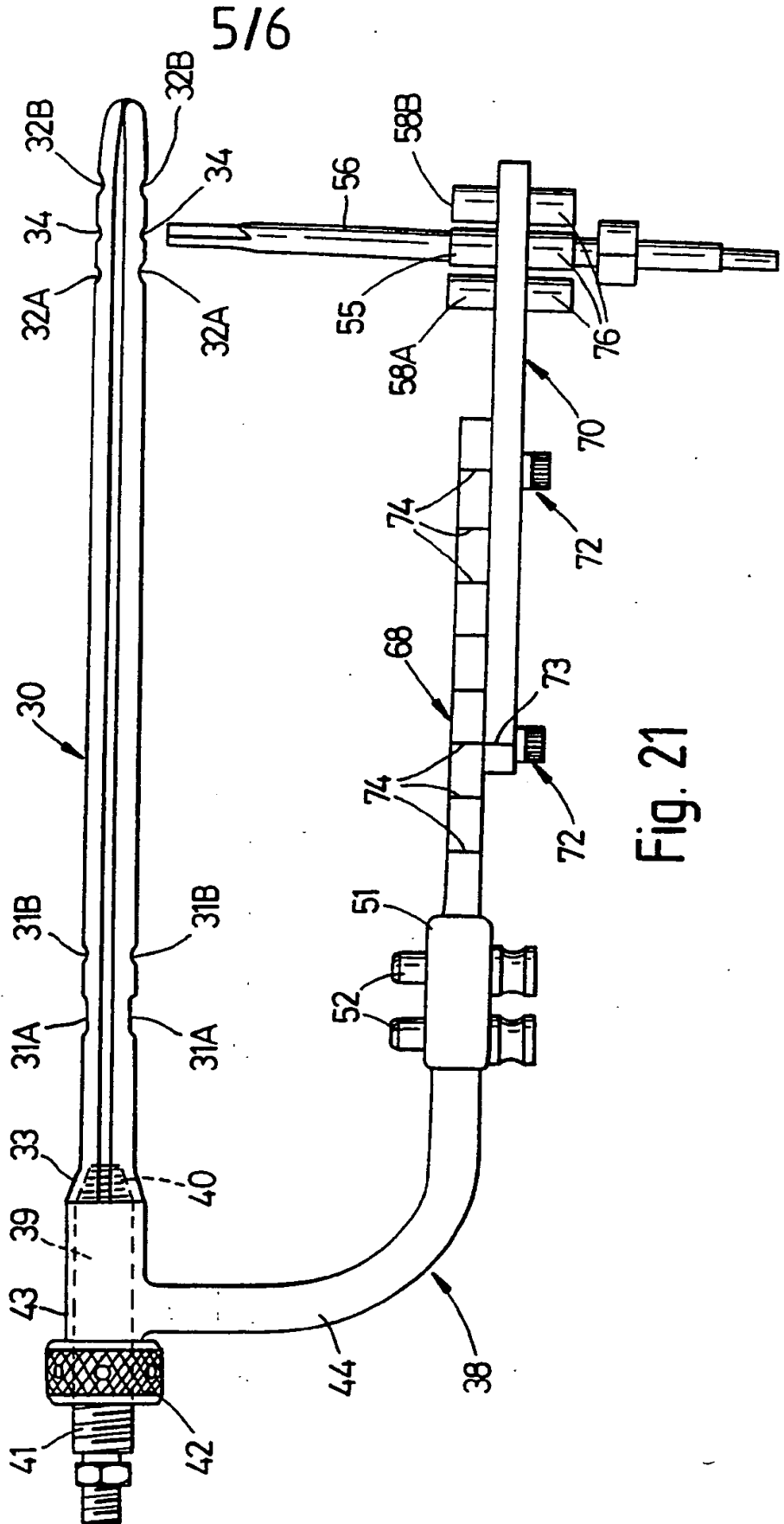
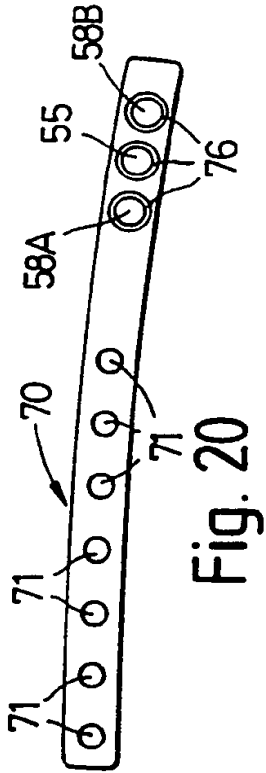
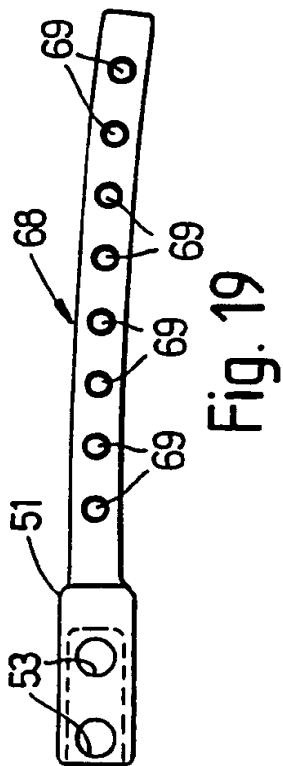
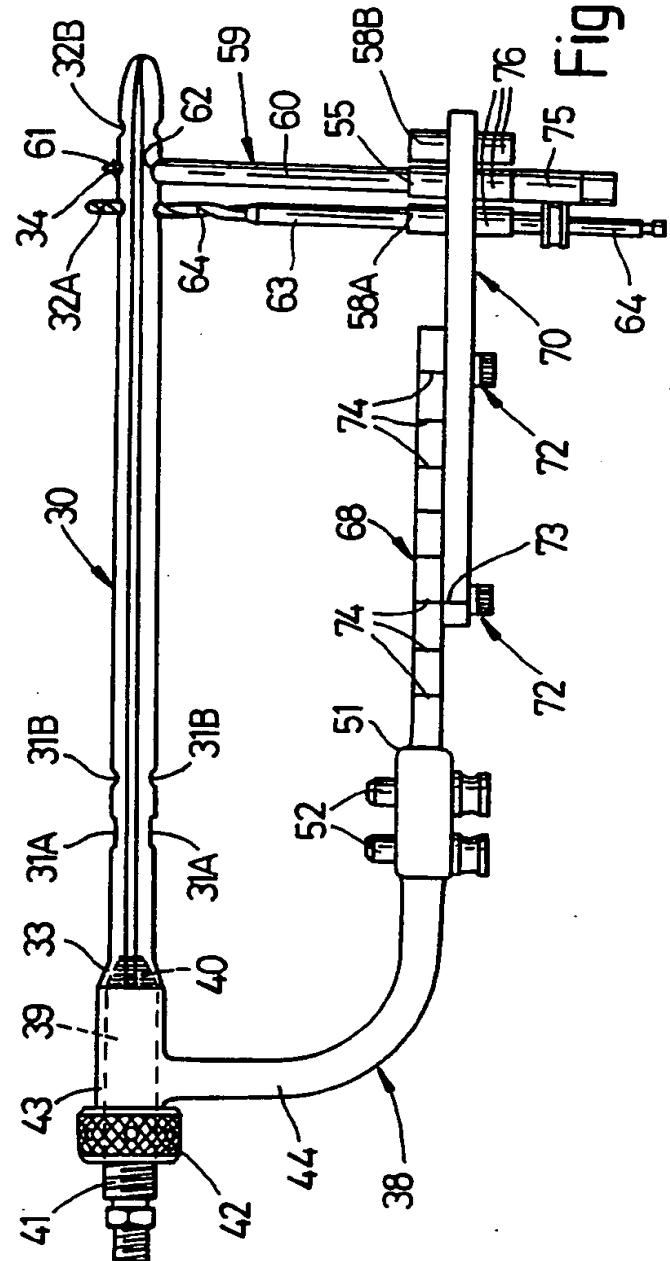
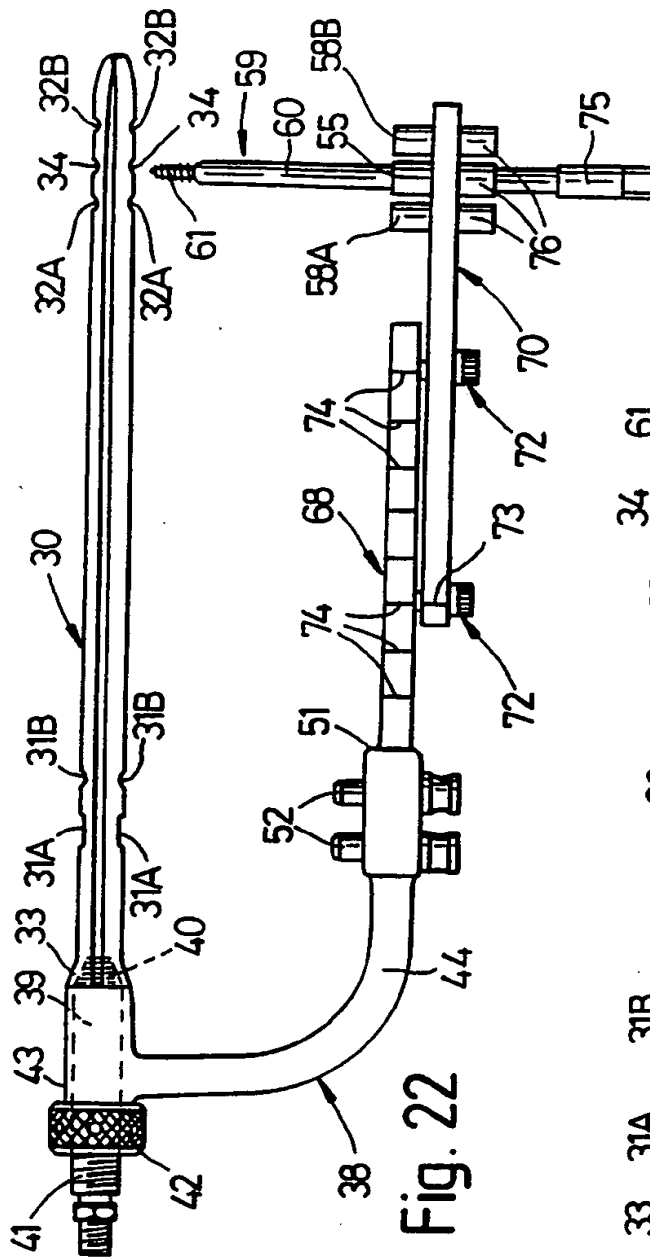


Fig. 18

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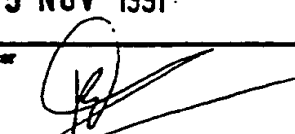
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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 91/01235

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5                      A61B17/16		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	A61B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	CH,A,668 692 (SYNTHES) 31 January 1989 see abstract; figure 1 ---	1,9
A	US,A,4 846 162 (MOEHRING) 11 July 1989 see abstract; figures 1-6 ---	1,9
<p><sup>10</sup> Special categories of cited documents :<sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
22 OCTOBER 1991	05 NOV 1991	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	MOERS R. 	

Form PCT/ISA/210 (second sheet) (January 1985)

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. GB 9101235  
SA 49602**

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 22/10/91

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CH-A-668692	31-01-89	None	
US-A-4846162	11-07-89	None	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82